Seasonal Dynamics of Mineral Uptake in Whole Pinot noir Vines in a red-hill soil

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Research Methods for Mineral Budget of Pinot noir vines

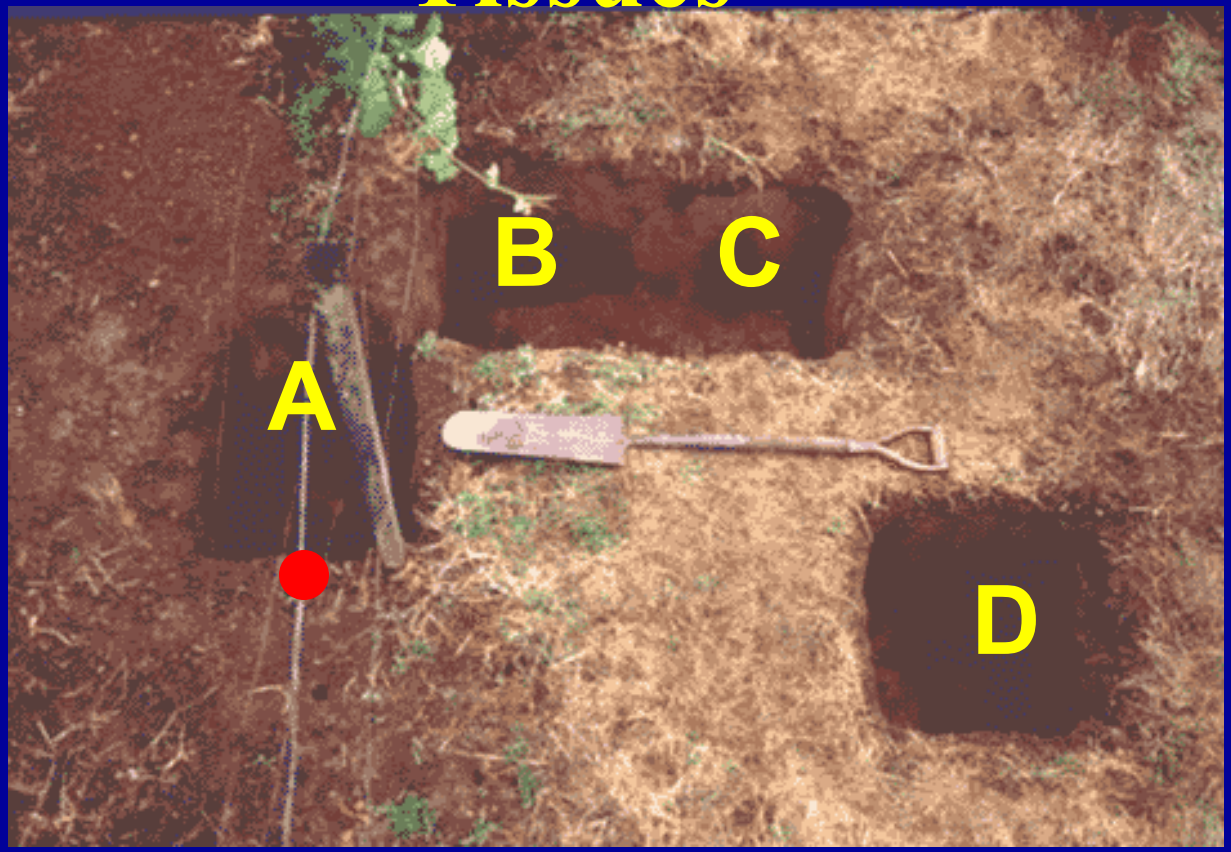
- Whole-vine mineral nutrient budget was conducted on 21-year-old vines at Woodhall 2001
- Mineral concentrations & contents were determined in 9 tissue types at 7 sampling times (4 reps)
- Roots were estimated by extraction from random soil monoliths (50 X 50 cm) representing 1/4 soil volume in vine rows and 1/8 soil volume in alleys
- Macro- & Micro-elements measured, except S
- Growers will benefit by knowing the timing of uptake of minerals, estimates of storage and reallocation of minerals, and the quantities of minerals that leave the system

Collection of Above-ground Tissues

1 - Fruit / Flowers – including stems
2 - Leaves
3 - Petioles
4 - Green Canes – including laterals
5 - Woody Canes
6 - Trunk – including below ground

Tissues were separated by hand. Whole samples or sub-samples were oven dried for 7 days and analyzed for N,P,K,Ca,Mg,Fe, Mn,Zn,B & Cu concentrations.

Estimation & Collection of Root Tissues



Field Picking of Roots

Handpicking to collect Fine Roots at the lab

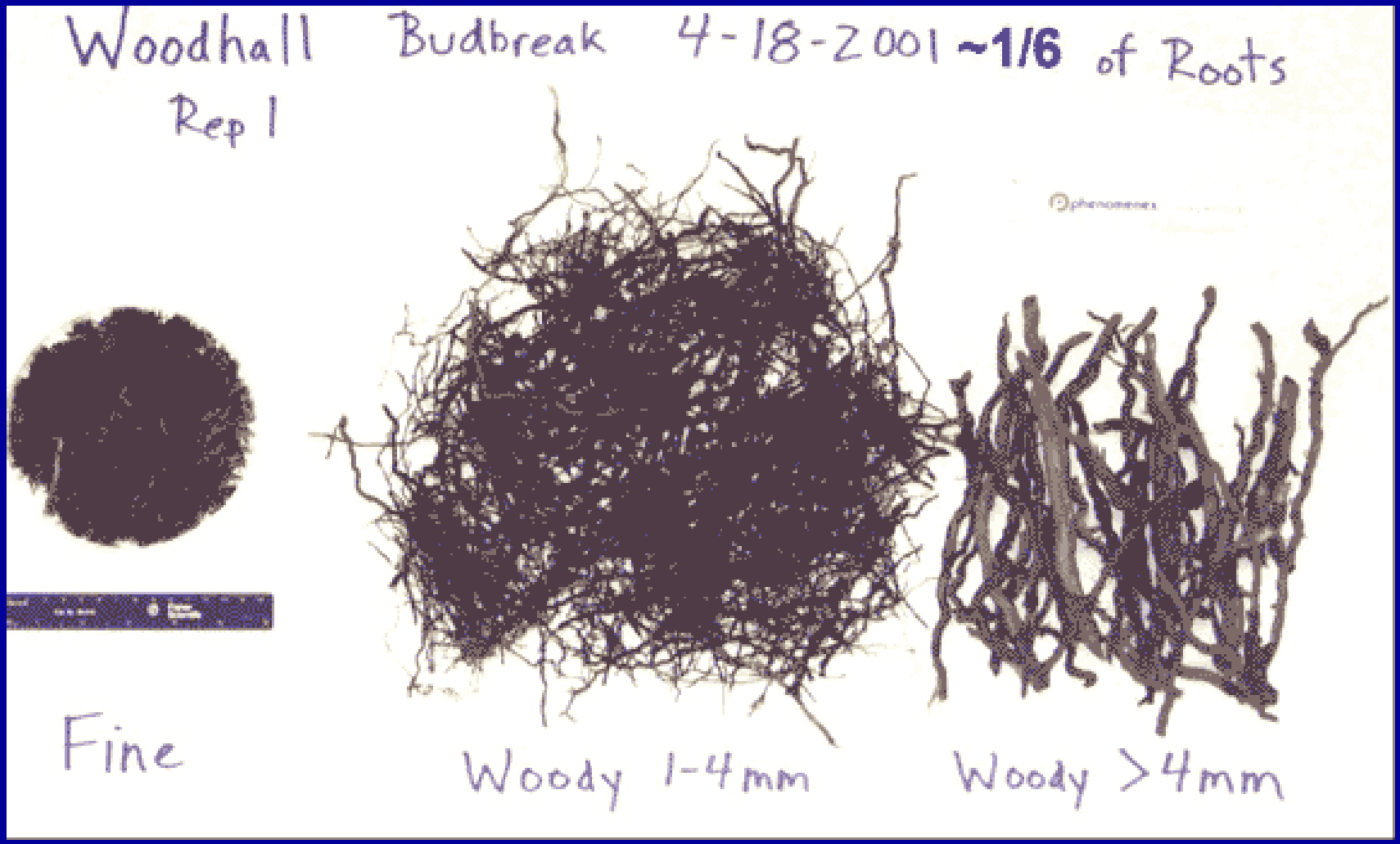
All roots were carefully washed to remove soil prior to oven drying.

Fine roots were sonicated to remove soil.

Fine root sub-samples used for mycorrhizal assays (Colon. & DNA)

Root Tissues Analyzed

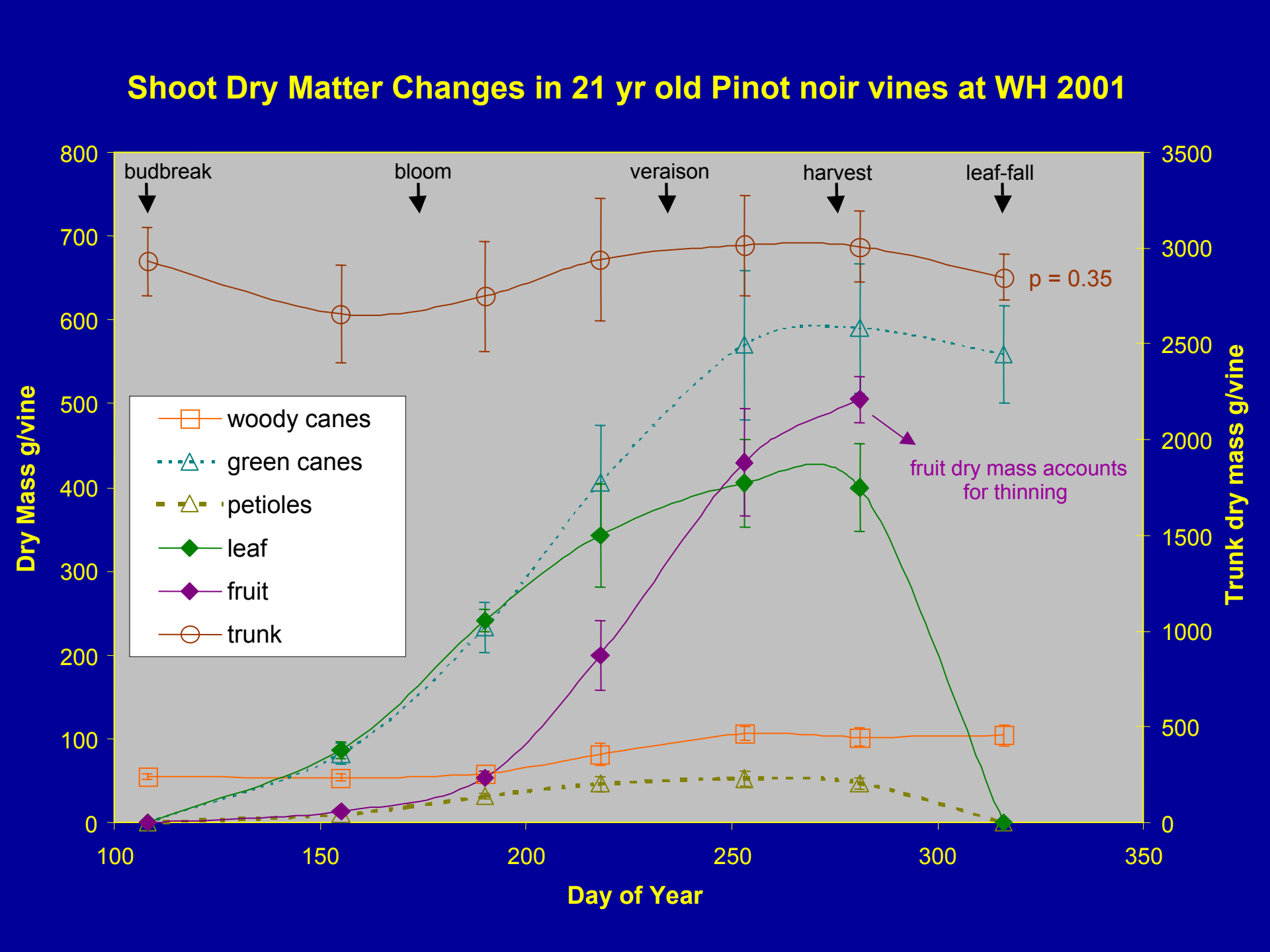
7 - Large woody roots (>4mm diam.)
8 - Small woody roots (1-4mm diam.)
9 - Fine roots (primary roots, cortex)



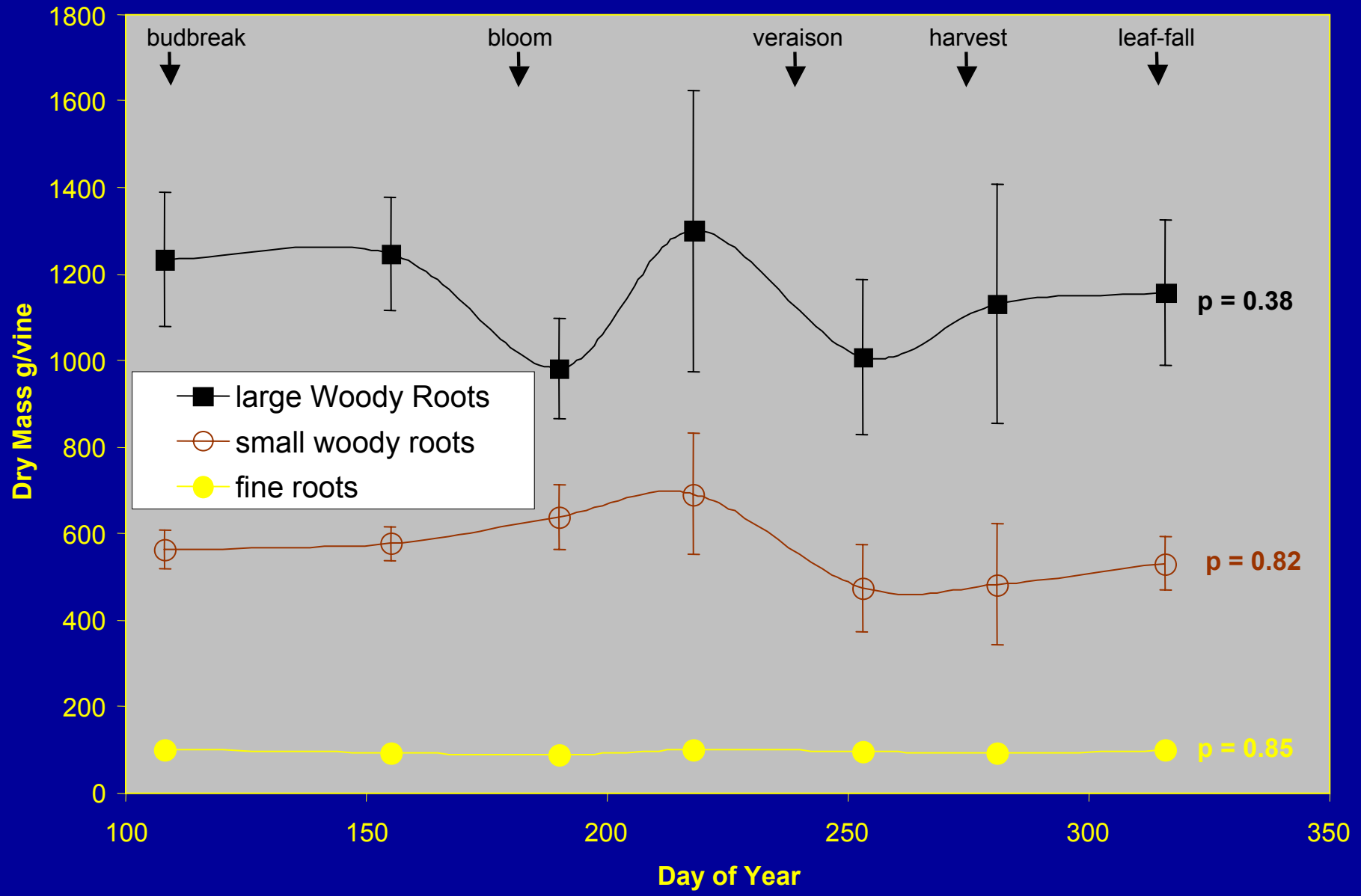
Netting to catch leaves October 16, 2001

What did we find?

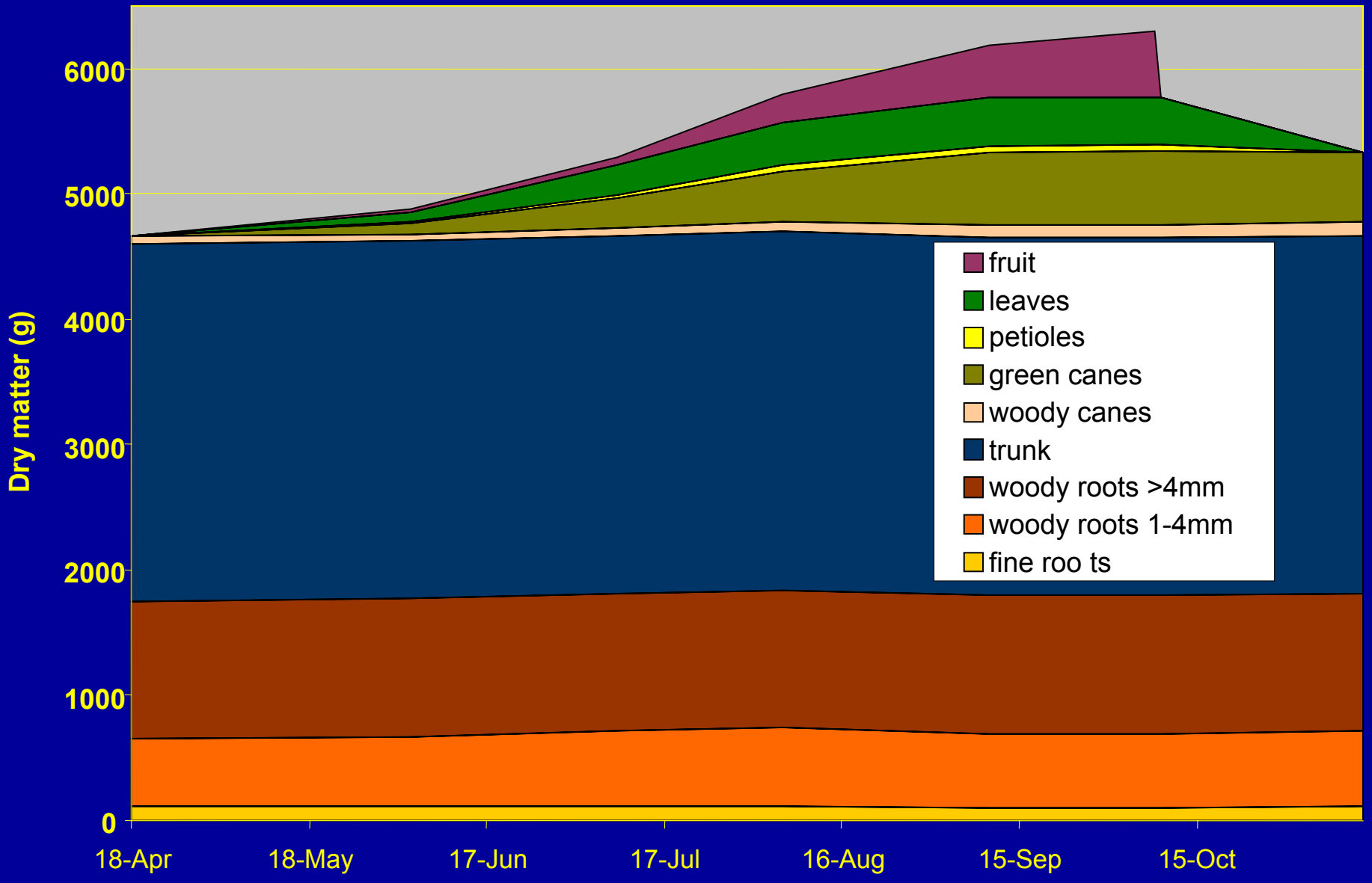
- Dry Matter Allocation
- Macro-Nutrient Concentrations and Contents
- Macro-Nutrient Uptake Rates
- Uptake versus Soil Nitrogen Availibility & Rainfall
- Comparison to Chenin Blanc budget
- Summarize Our Findings (Uptake, Losses and Re-Allocation from Reserves)

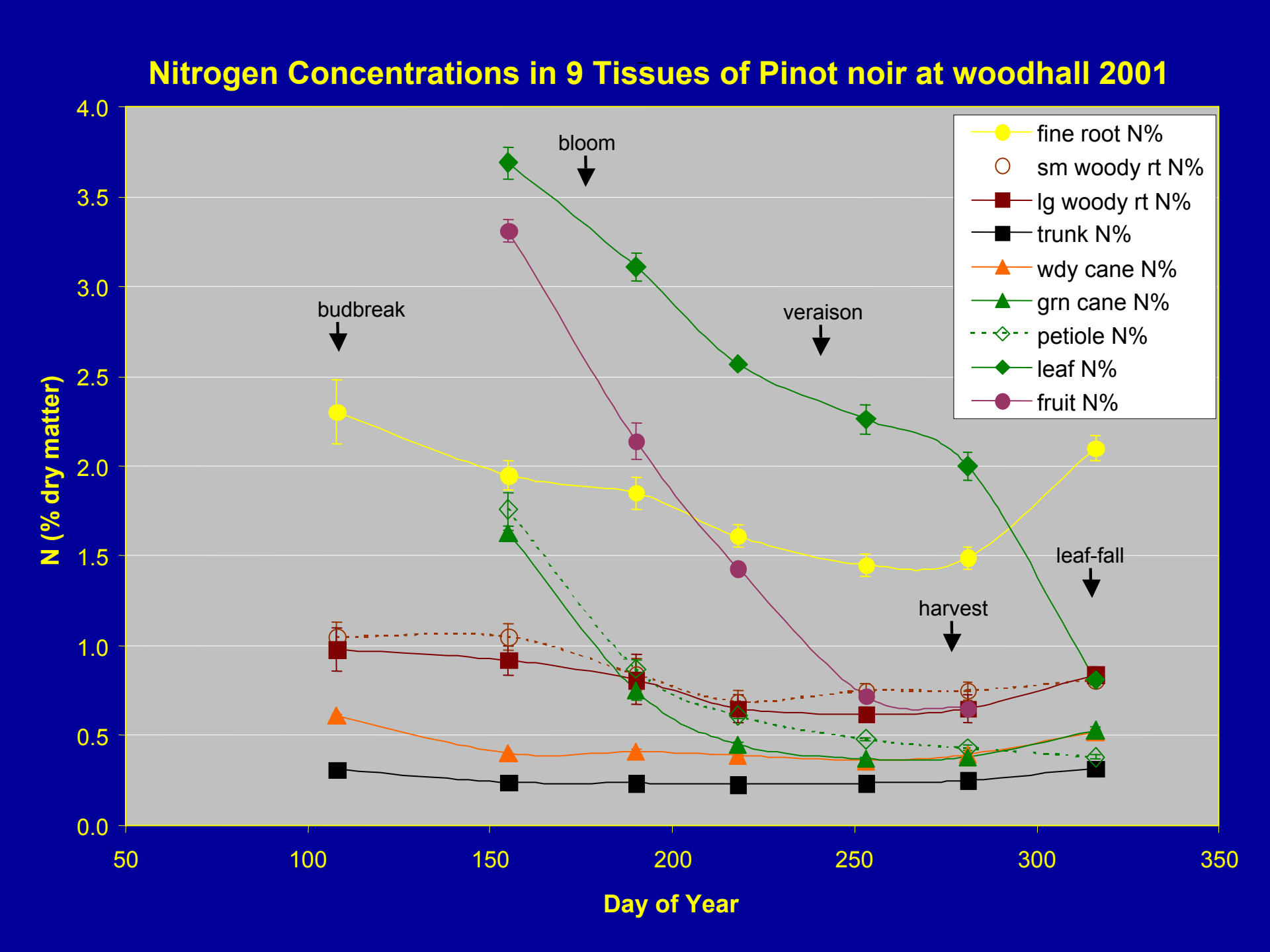

Shoot Dry Matter Changes in 21 yr old Pinot noir vines at WH 2001
budbreak
bloom
veraison
harvest
leaf-fall
p = 0.35
fruit dry mass accounts for thinning
woody canes
green canes
petioles
leaf
fruit
trunk
Dry Mass g/vine
Trunk dry mass g/vine
Day of Year
800
700
600
500
400
300
200
100
0
3500
3000
2500
2000
1500
1000
500
0
100
150
200
250
300
350

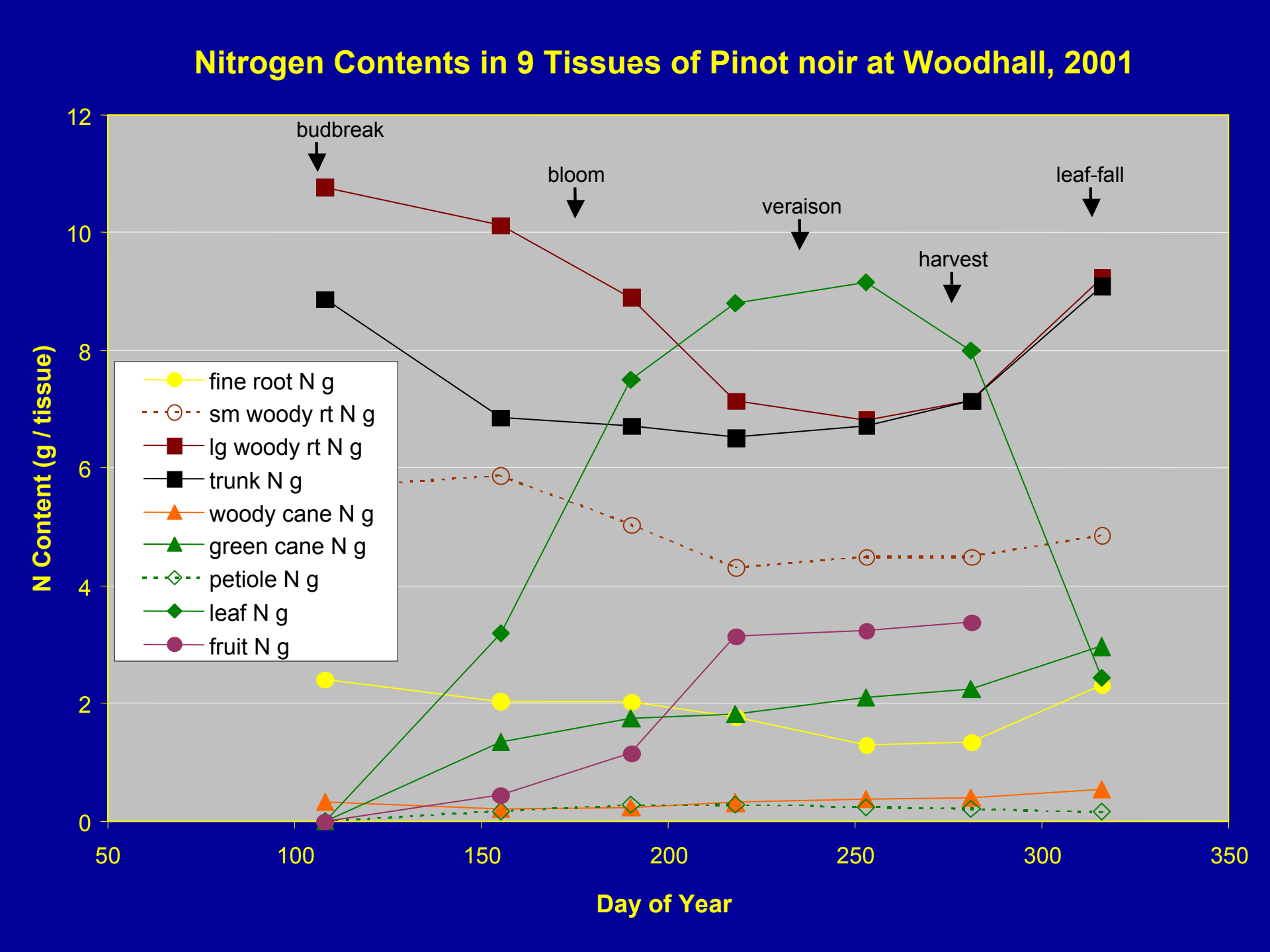
Root Dry Matter Changes in 21 yr old Pinot noir vines at WH 2001



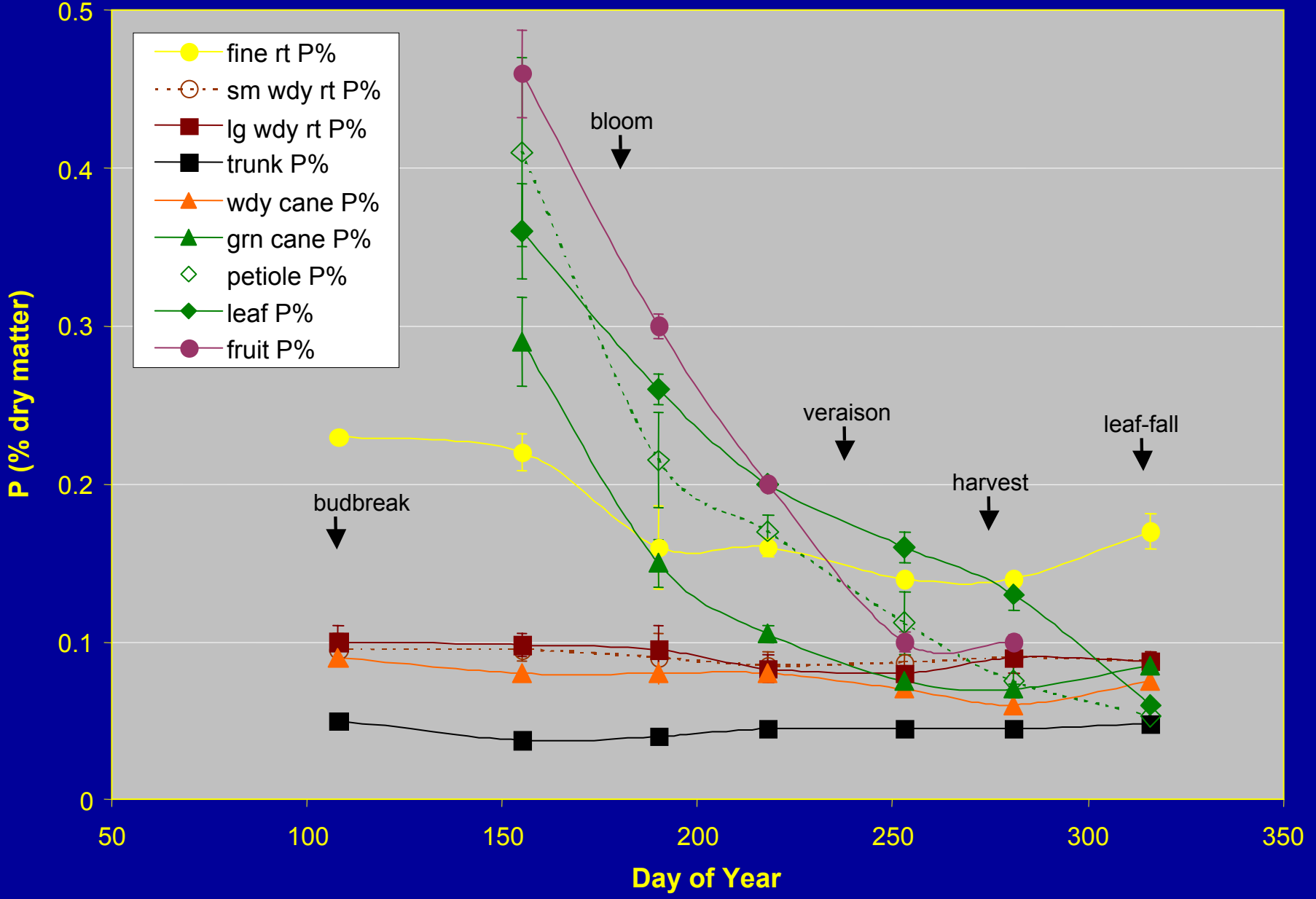
Dry Matter Accumulation in 21-yr-old Pinot noir vines, WH 2001



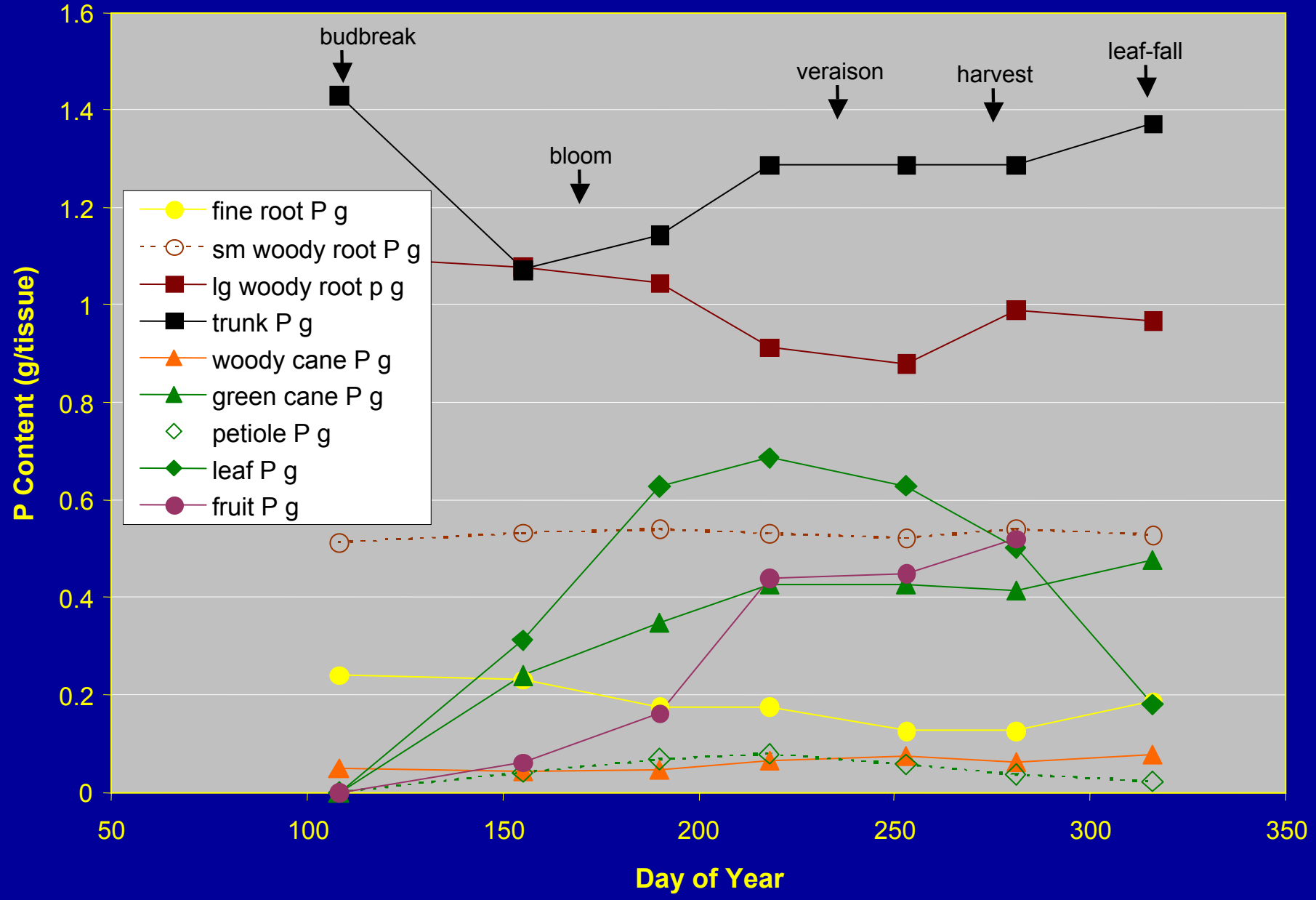

Nitrogen Concentrations in 9 Tissues of Pinot noir at woodhall 2001
N (% dry matter)
Day of Year
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
50
100
150
200
250
300
350
budbreak
bloom
veraison
harvest
leaf-fall
fine root N%
sm woody rt N%
lg woody rt N%
trunk N%
wdy cane N%
grn cane N%
petiole N%
leaf N%
fruit N%

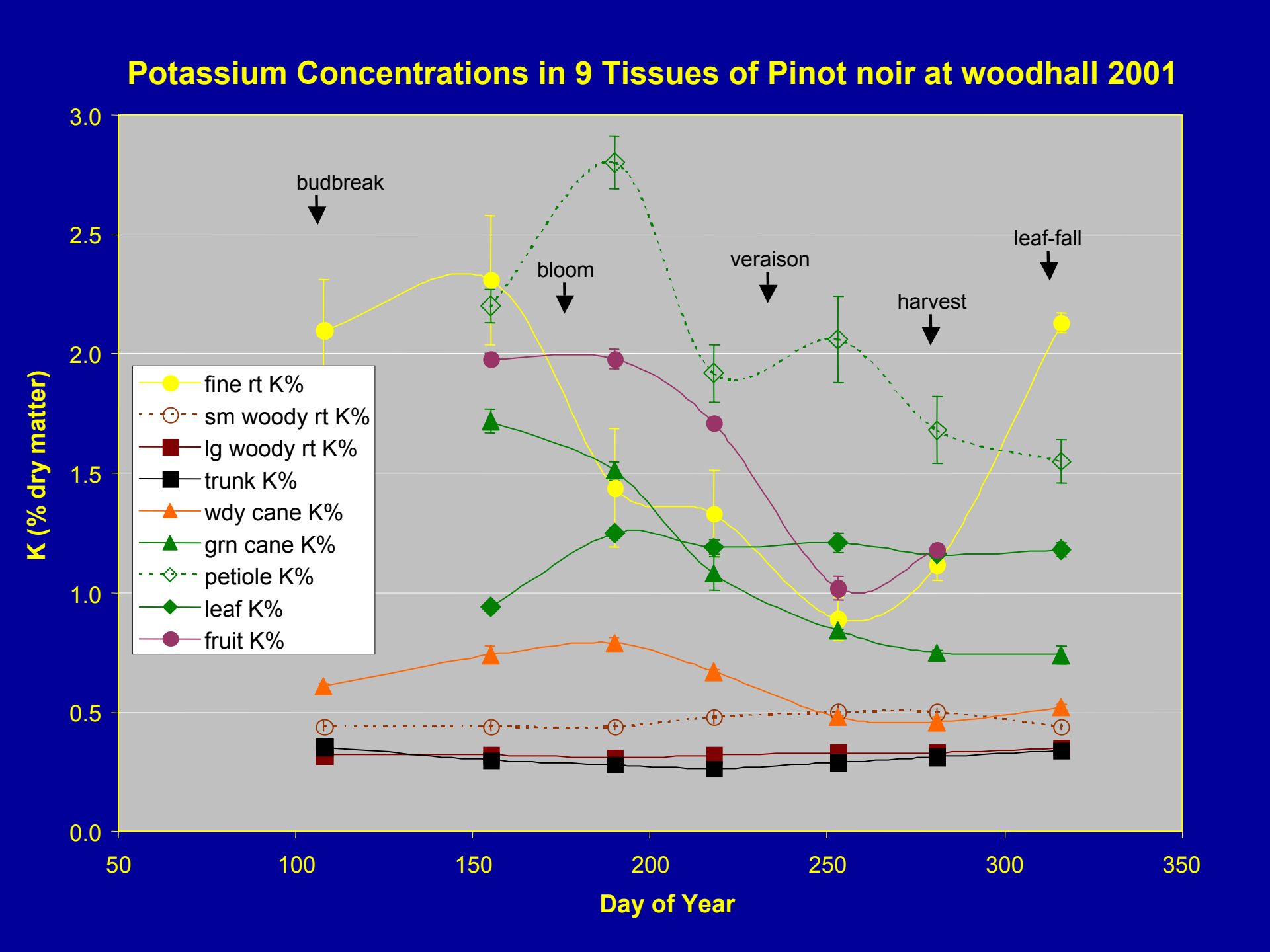

Nitrogen Contents in 9 Tissues of Pinot noir at Woodhall, 2001
budbreak
bloom
veraison
harvest
leaf-fall
fine root N g
sm woody rt N g
lg woody rt N g
trunk N g
woody cane N g
green cane N g
petiole N g
leaf N g
fruit N g
N Content (g / tissue)
Day of Year
0
2
4
6
8
10
12
50
100
150
200
250
300
350

Phosphorus Concentrations in 9 Tissues of Pinot noir at woodhall 2001

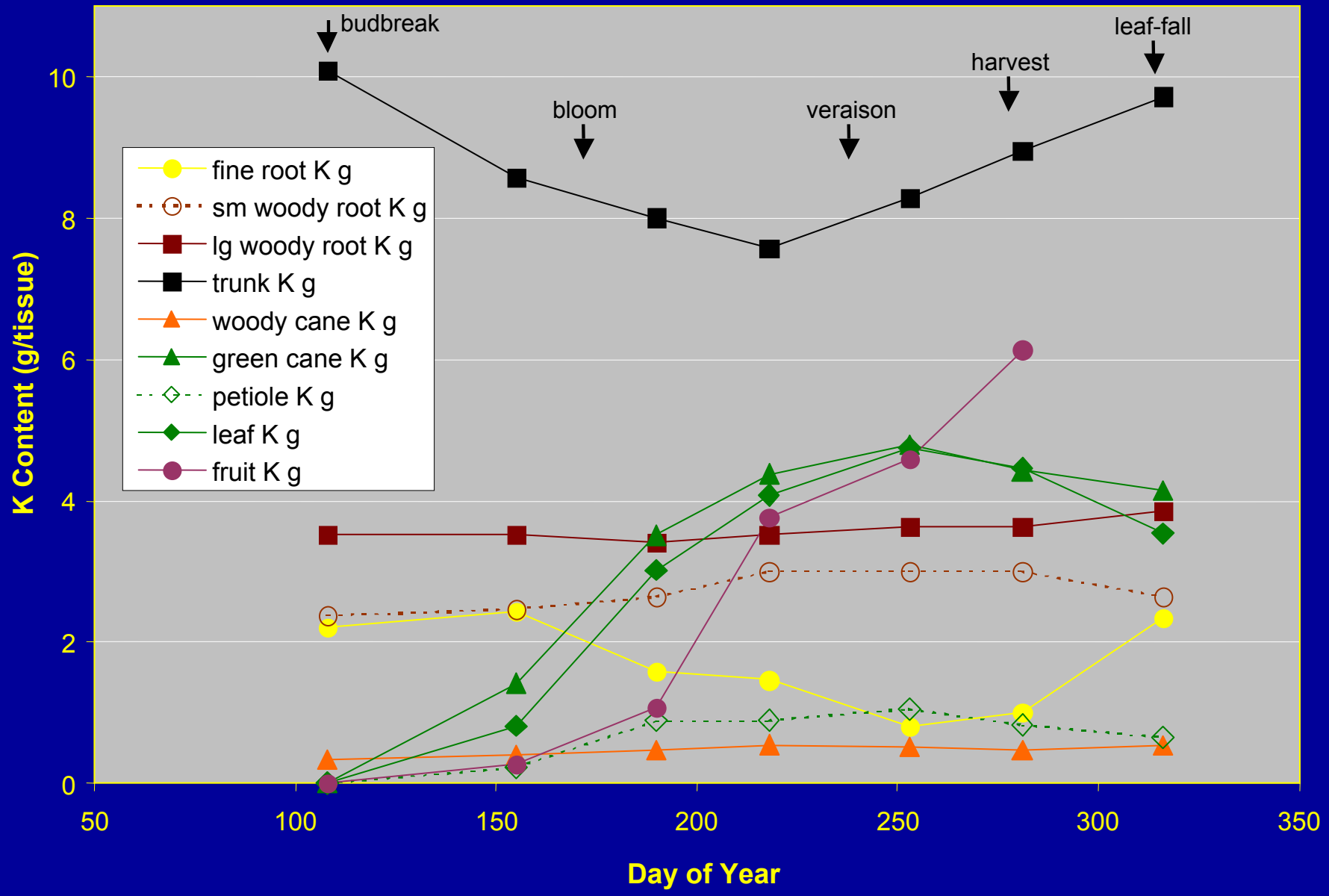


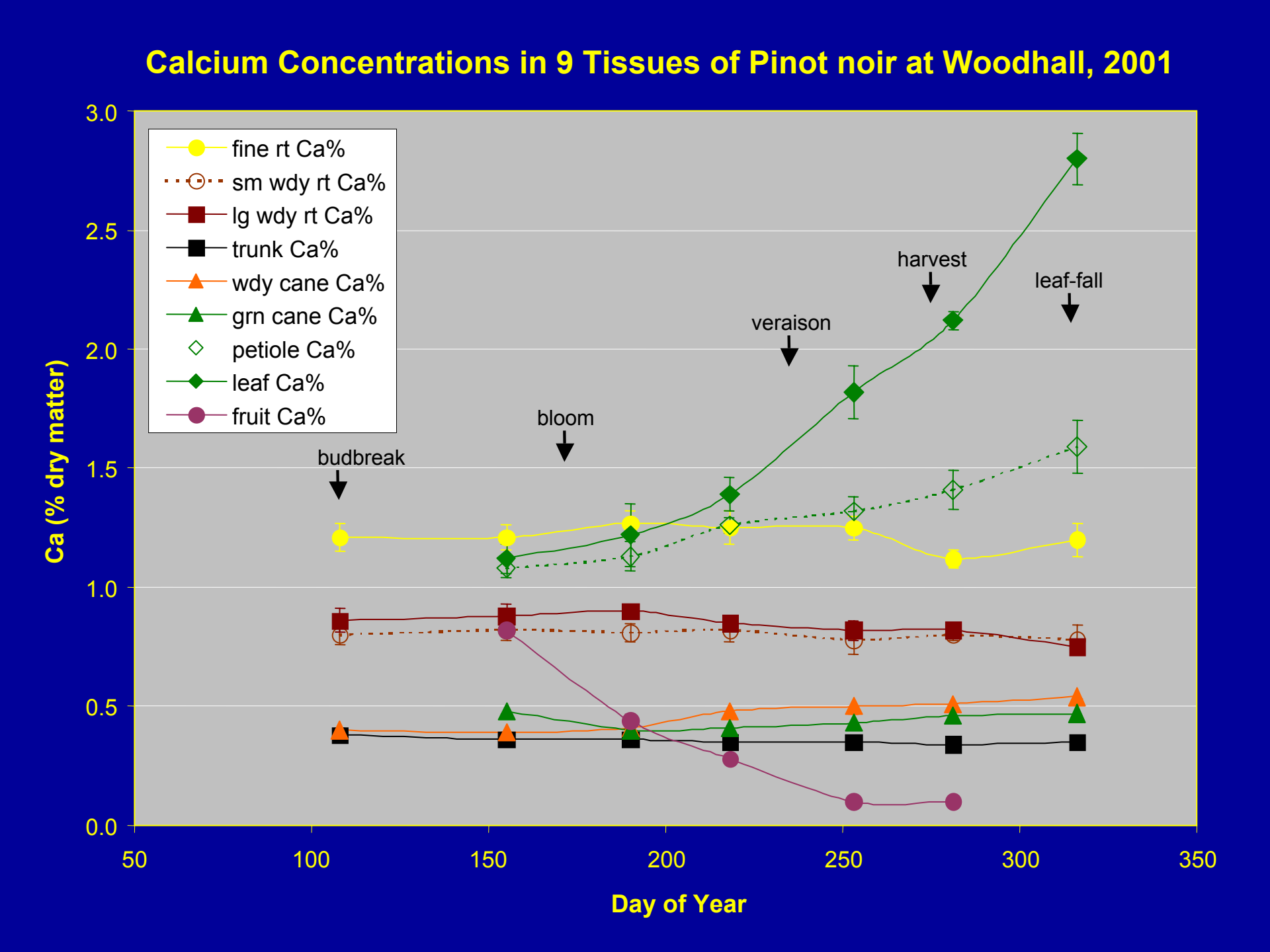
Phosphorus Contents in 9 Tissues of Pinot noir at Woodhall, 2001



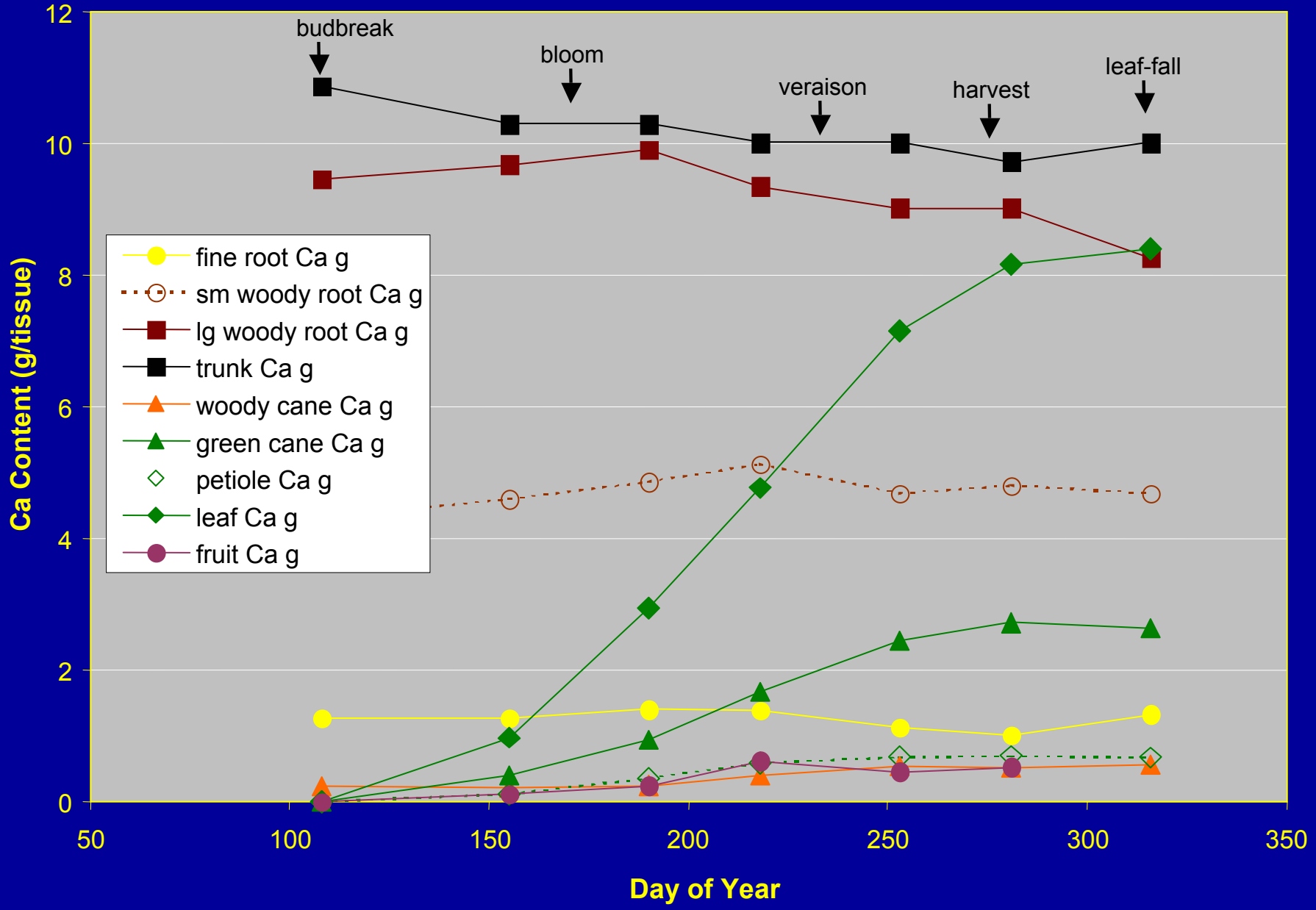

Potassium Concentrations in 9 Tissues of Pinot noir at woodhall 2001
K (% dry matter)
Day of Year
3.0
2.5
2.0
1.5
1.0
0.5
0.0
50
100
150
200
250
300
350
budbreak
bloom
veraison
harvest
leaf-fall
fine rt K%
sm woody rt K%
lg woody rt K%
trunk K%
wdy cane K%
grn cane K%
petiole K%
leaf K%
fruit K%

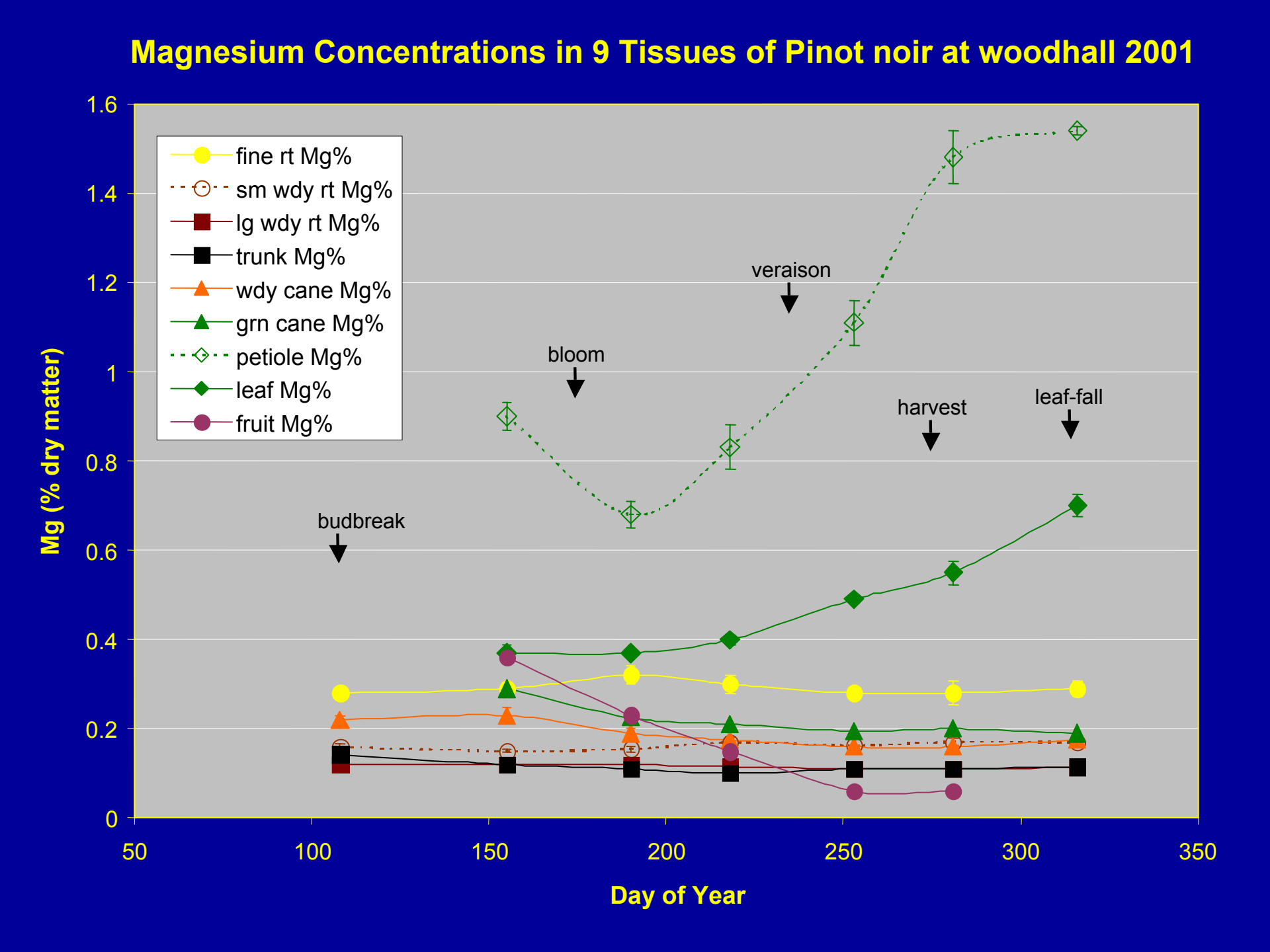
Potassium Contents in 9 Tissues of Pinot noir at Woodhall, 2001

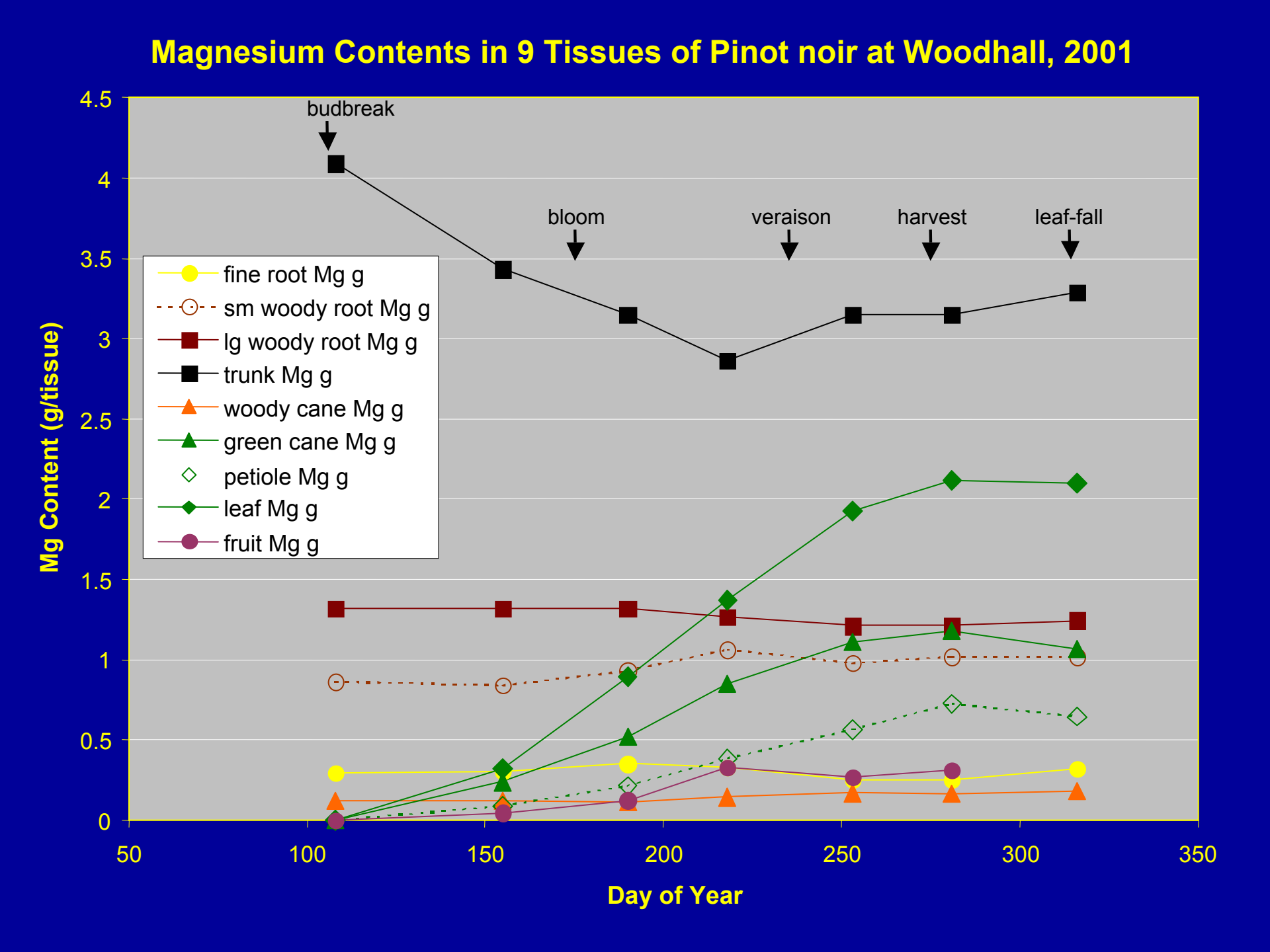



Calcium Concentrations in 9 Tissues of Pinot noir at Woodhall, 2001
fine rt Ca%
sm wdy rt Ca%
lg wdy rt Ca%
trunk Ca%
wdy cane Ca%
grn cane Ca%
petiole Ca%
leaf Ca%
fruit Ca%
budbreak
bloom
veraison
harvest
leaf-fall
Ca (% dry matter)
Day of Year
3.0
2.5
2.0
1.5
1.0
0.5
0.0
50
100
150
200
250
300
350

Calcium Contents in 9 Tissues of Pinot noir at Woodhall, 2001

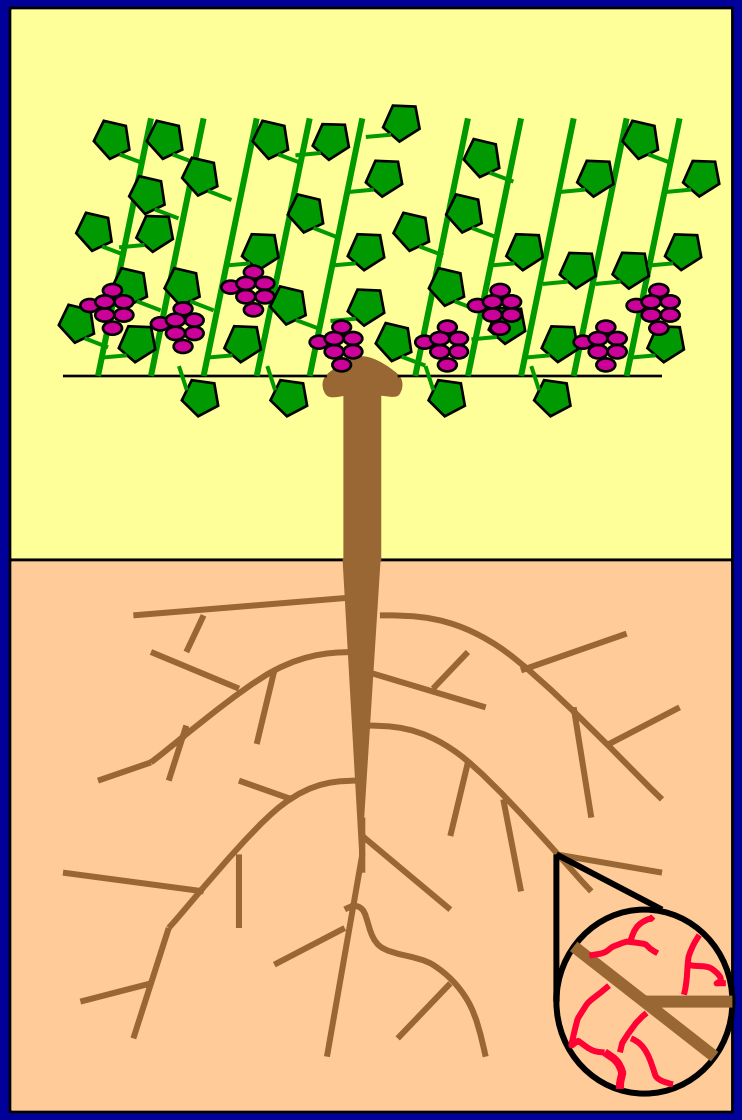



Magnesium Concentrations in 9 Tissues of Pinot noir at woodhall 2001
Mg (% dry matter)
Day of Year
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
50
100
150
200
250
300
350
fine rt Mg%
sm wdy rt Mg%
lg wdy rt Mg%
trunk Mg%
wdy cane Mg%
grn cane Mg%
petiole Mg%
leaf Mg%
fruit Mg%
budbreak
bloom
veraison
harvest
leaf-fall


Magnesium Contents in 9 Tissues of Pinot noir at Woodhall, 2001
budbreak
bloom
veraison
harvest
leaf-fall
fine root Mg g
sm woody root Mg g
lg woody root Mg g
trunk Mg g
woody cane Mg g
green cane Mg g
petiole Mg g
leaf Mg g
fruit Mg g
Mg Content (g/tissue)
Day of Year
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
50
100
150
200
250
300
350

Calculating Demand & Uptake of Vines

21 yr-old Pinot noir vines at Woodhall

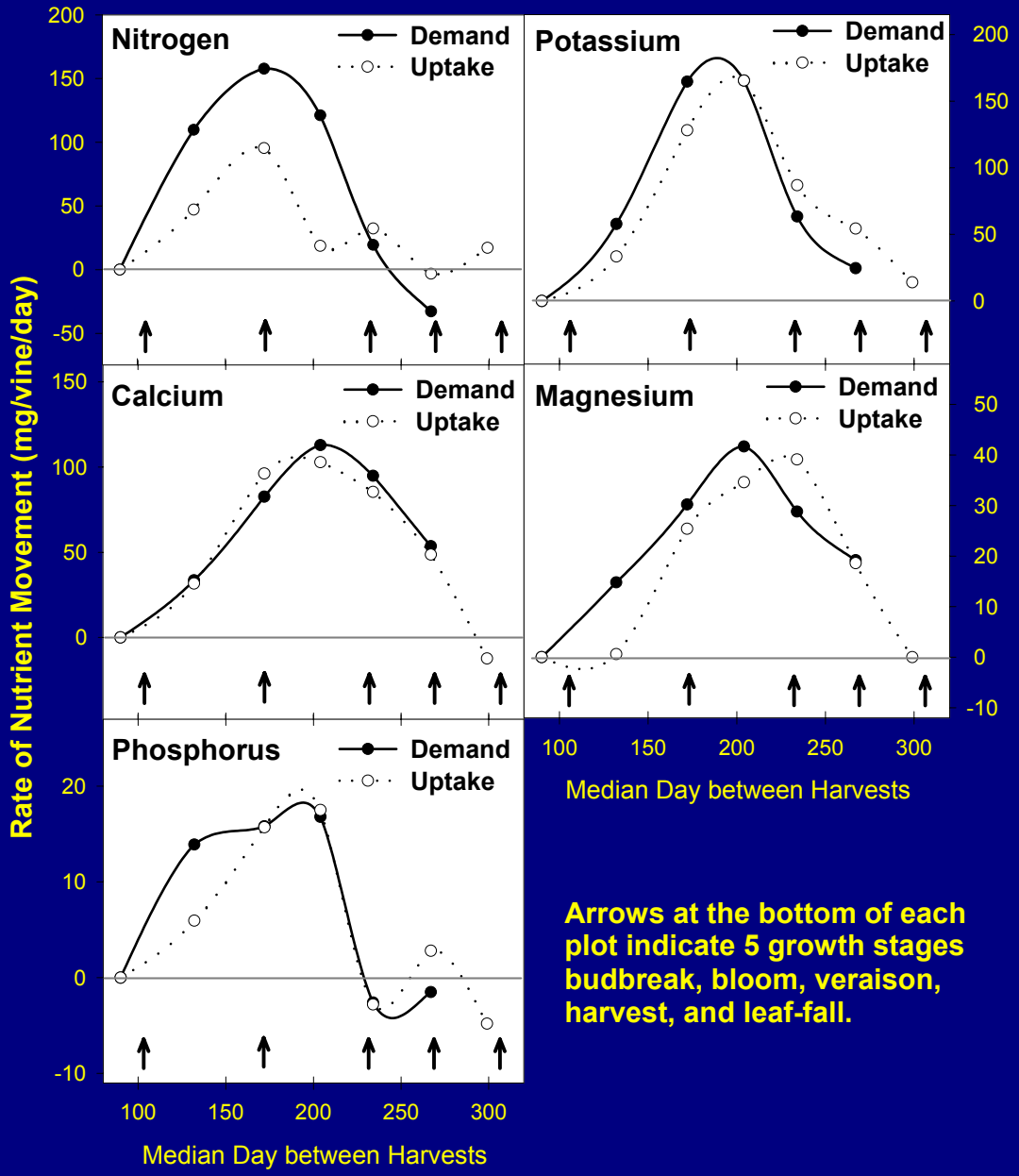


Canopy Demand = Change in total content of each mineral in green canes + petioles + leaves + fruit between selected sampling times.

Vine Uptake = Change in total content of each mineral in all tissues between selected sampling times.

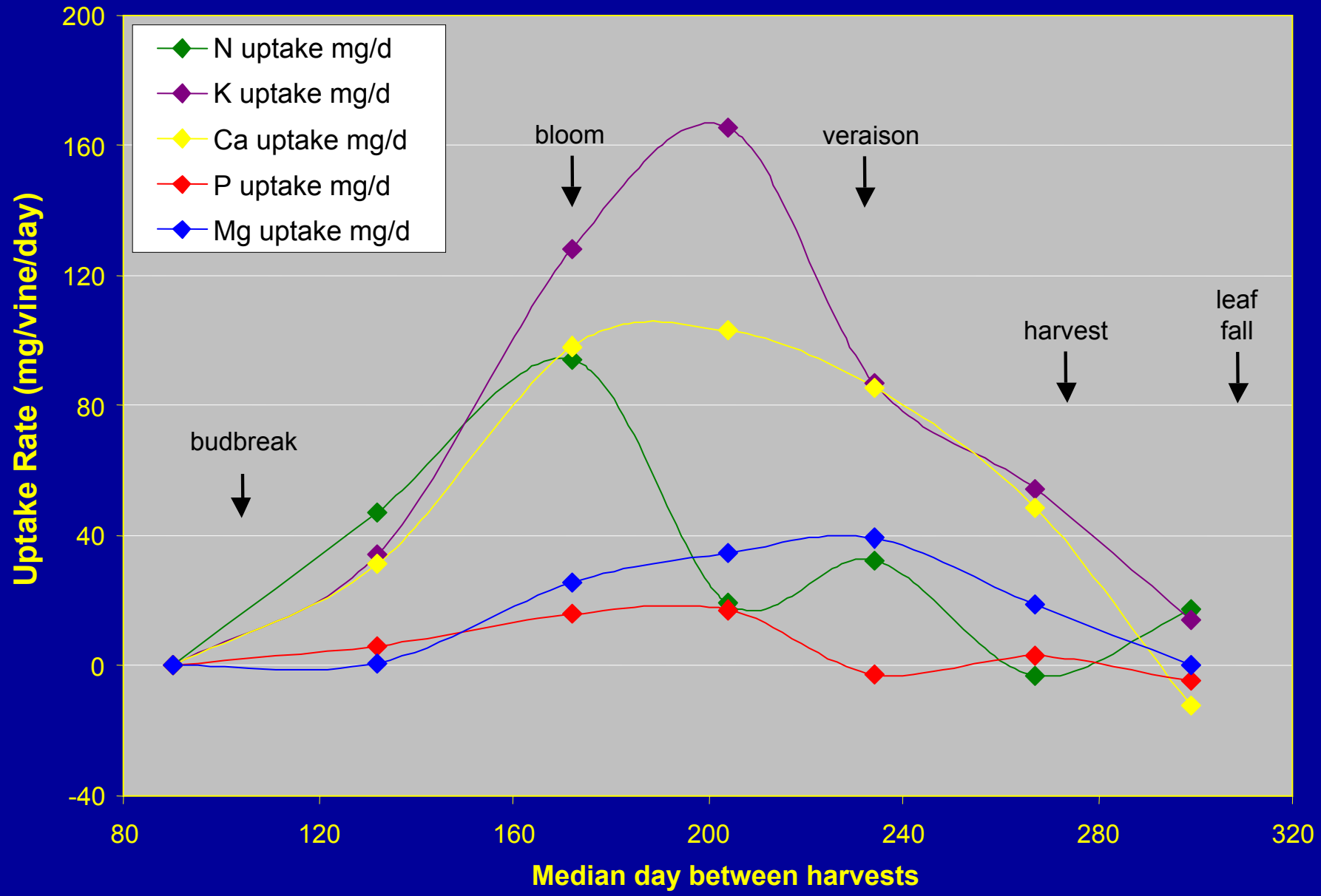
Content = concentration of mineral X dry mass.

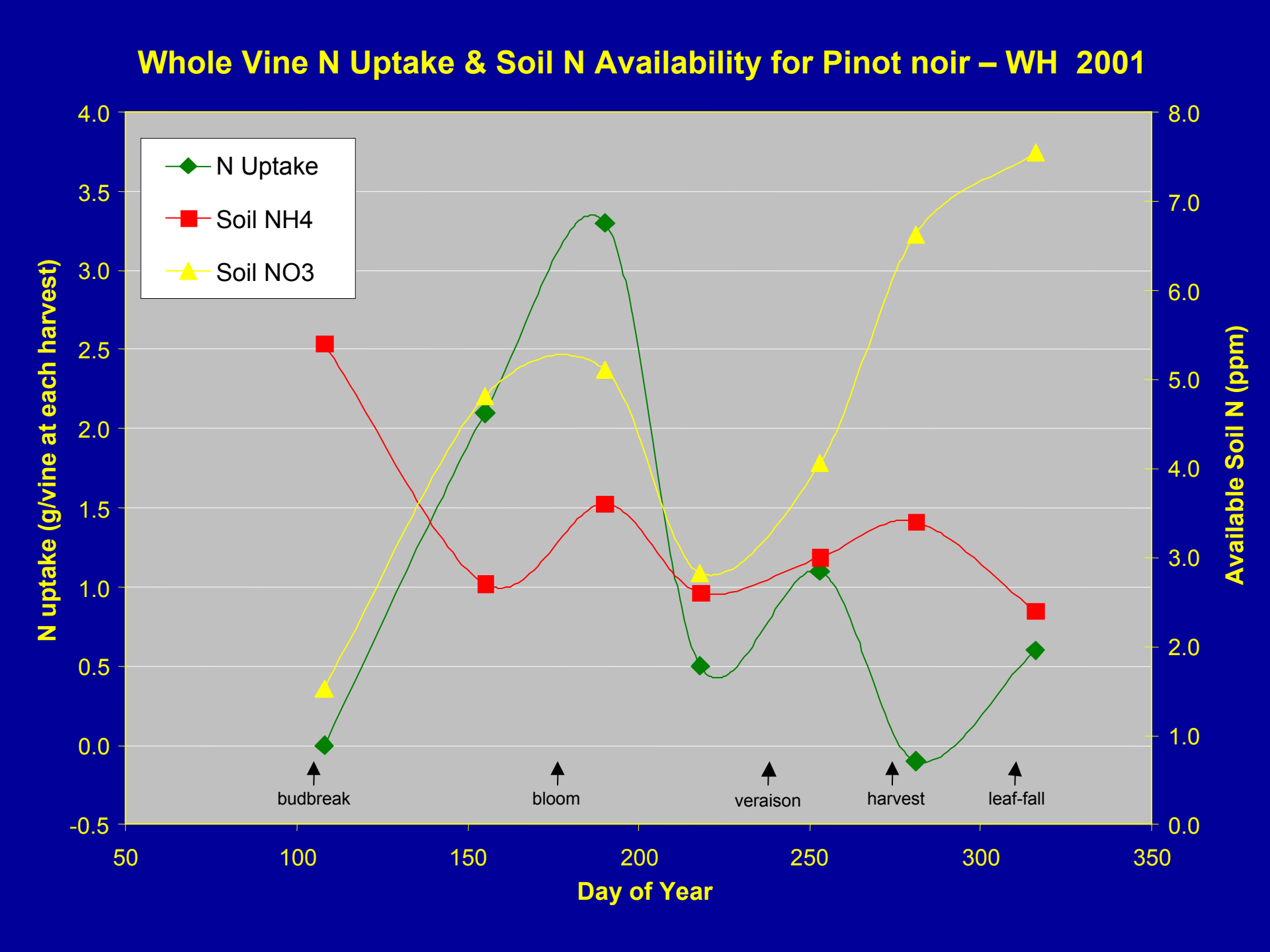
Figure 2. Canopy Demand and Whole-Vine Uptake of Macronutrients

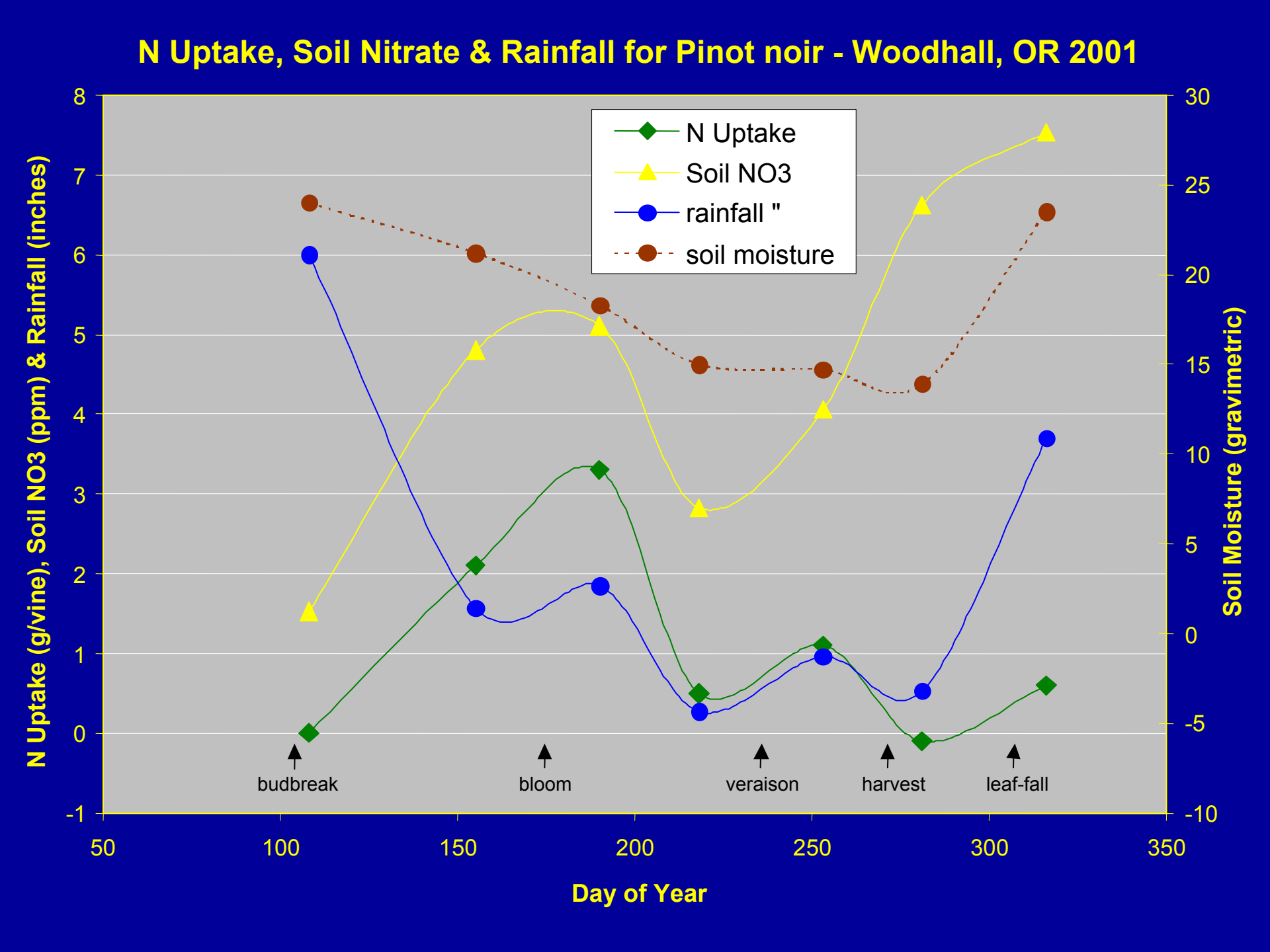


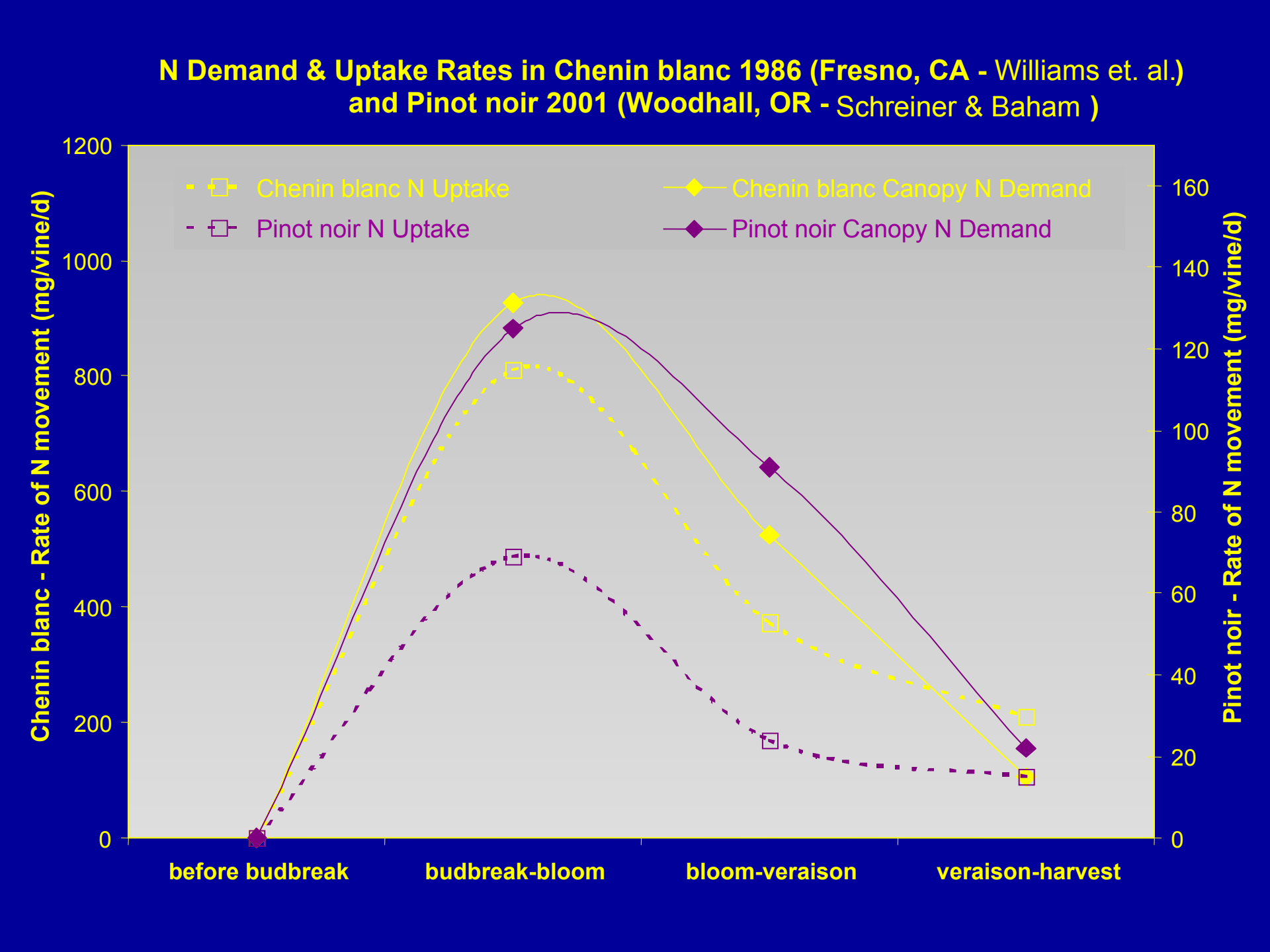
Arrows at the bottom of each plot indicate 5 growth stages budbreak, bloom, veraison, harvest, and leaf-fall.

Whole Vine Daily Uptake Rates of Macronutrients in Pinot noir, WH 2001




Whole Vine N Uptake & Soil N Availability for Pinot noir – WH 2001
N Uptake
Soil NH4
Soil NO3
N uptake (g/vine at each harvest)
Available Soil N (ppm)
Day of Year
budbreak
bloom
veraison
harvest
leaf-fall
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
50
100
150
200
250
300
350


N Uptake, Soil Nitrate & Rainfall for Pinot noir - Woodhall, OR 2001
N Uptake
Soil NO3
rainfall "
soil moisture
N Uptake (g/vine), Soil NO3 (ppm) & Rainfall (inches)
Soil Moisture (gravimetric)
Day of Year
budbreak
bloom
veraison
harvest
leaf-fall
8
7
6
5
4
3
2
1
0
-1
30
25
20
15
10
5
0
-5
-10
50
100
150
200
250
300
350


N Demand & Uptake Rates in Chenin blanc 1986 (Fresno, CA - Williams et. al.) and Pinot noir 2001 (Woodhall, OR - Schreiner & Baham)
Chenin blanc N Uptake
Pinot noir N Uptake
Chenin blanc Canopy N Demand
Pinot noir Canopy N Demand
Chenin blanc - Rate of N movement (mg/vine/d)
Pinot noir - Rate of N movement (mg/vine/d)
0
200
400
600
800
1000
1200
0
20
40
60
80
100
120
140
160
before budbreak
budbreak-bloom
bloom-veraison
veraison-harvest

Summary of Macro-nutrient Use in Pinot noir 2001 in Pounds / acre

Nutrient	Canopy Demand by harvest	Soil Uptake by harvest	Fruit Losses	Leaf Re-alloc.	Post-harvest Uptake
N	25.8	12.7	5.9	7.9	1.0
P	2.8	2.3	1.0	0.6	-0.3
K	28.0	26.6	10.8	1.8	0.8
Ca	21.8	21.3	1.0	-0.4	-0.7
Mg	7.4	6.2	0.6	0.1	0

Relative Importance of Various Tissues to supply Macro-nutrients from Reserves

Nutrient	Fine Roots	Small Woody Roots	Large Woody Roots	Trunk	% Canopy Demand from Reserves
N	13.3%	13.9%	47.2%	25.5%	51.0 %
P	25.0%	0	45.8%	29.2%	27.0 %
K	45.3%	0	0	54.7%	10.5 %
Ca	8.9%	0	27.8%	63.3%	2.0 %
Mg	3.5%	0	9.6%	86.9%	17.8 %

Conclusions from 2001 Nutrient Budget Study

- Macro-nutrient uptake was closely tied to canopy demand for most nutrients.
- Micro-nutrient data was highly variable.
- N and (to some extent P) uptake was early in the season & much from reserves (N - 51%, P - 27%).
- K, Ca and Mg uptake was later in the season & far less from reserves (K - 10%, Ca - 2%, Mg - 18%).
- Most important reserve tissues were: large roots for N & P, trunk & fine roots for K, trunk for Mg
- Recapture of leaf nutrients significant for N & P.
- Which nutrient limiting growth unclear (N, P, Zn, or Ca & Mg are possible candidates).

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OSU

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Matt Compton
Jeff Cygan

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USDA, OSU, OWAB

Future Plans for this Project

- Construct a similar budget in 2002 to address year-to year variation.
- More careful selection of vines to be harvested based on trunk size, woody cane diameters, & 2001 pruning weights.
- Gypsum ($CaSO_4$) added to half of the vines to be harvested to address the issue of calcium limitation in red-hill soils.
- Examine impact of subsoil gypsum on root growth in subsoil, Ca uptake, cane growth rates, fruit set, & fruit quality.

Gypsum Treatments
Applied to select vines
At Woodhall Feb. 15, 2002

Gypsum applied
In 30 cores/vine
9lb $CaSO_4$/vine
~18 ton/acre